A MOLECULAR FOUNTAIN

CUNFENG CHENG, AERNOUT P.P. VAN DER POEL, WIM UBACHS, HENDRICK BETHLEM, *Department of Physics and Astronomy, VU University , Amsterdam, Netherlands*.

The resolution of any spectroscopic experiment is limited by the coherent interaction time between the probe radiation and the particle that is being studied. The introduction of cooling techniques for atoms and ions has resulted in a dramatic increase of interaction times and accuracy, it is hoped that molecular cooling techniques will lead to a similar increase. Here we demonstrate the first molecular fountain, a development which permits hitherto unattainably long interrogation times with molecules. In our experiment, beams of ammonia molecules are decelerated, trapped and cooled using inhomogeneous electric fields and subsequently launched. Using a combination of quadrupole lenses and buncher elements, the beam is shaped such that it has a large position spread and a small velocity spread (corresponding to a transverse temperature of less than 10μK and a longitudinal temperature of less than 1μK) while the molecules are in free fall, but strongly focused at the detection region. The molecules are in free fall for up to 266 milliseconds, making it possible, in principle, to perform sub-Hz measurements in molecular systems and paving the way for stringent tests of fundamental physics theories.